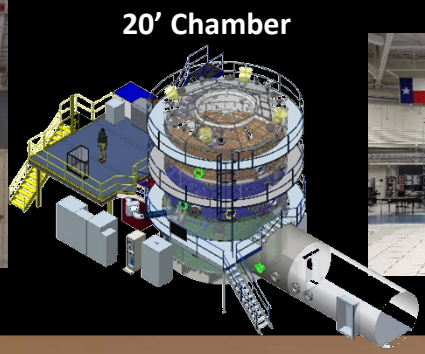
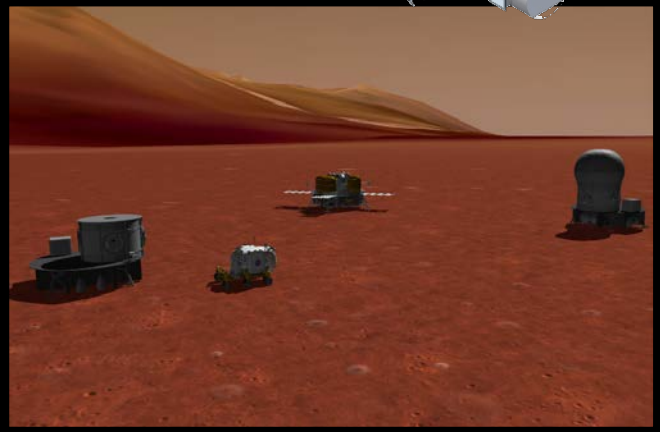
HUMAN EXPLORATION SPACECRAFT TESTBED FOR INTEGRATION AND ADVANCEMENT





HESTIA Integration and Test
Bill Othon/EG

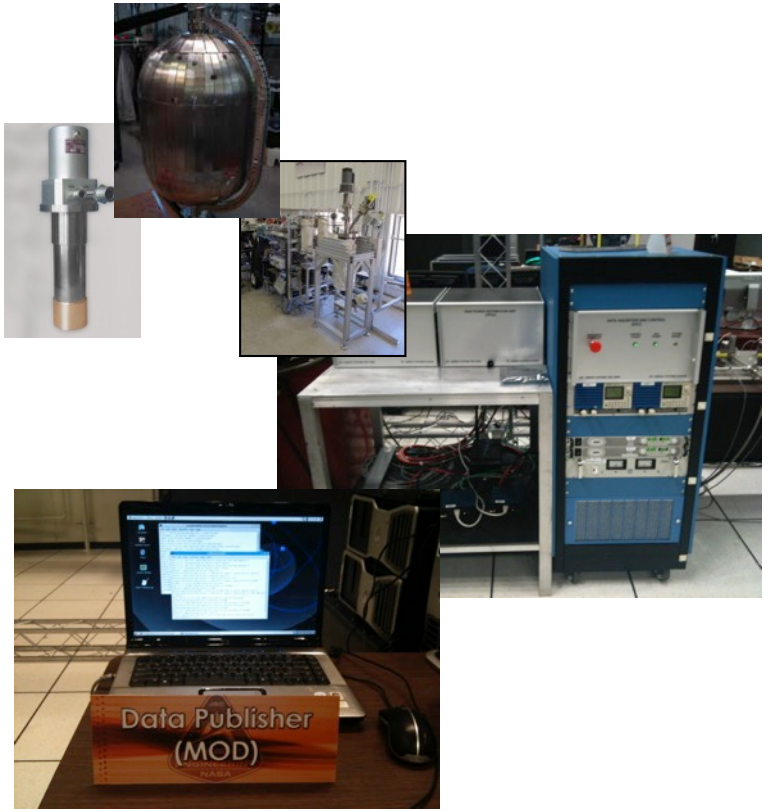
AIAA Technical Symposium
5 May 2016

Development Focus

- Capabilities driven
  - Identify gaps, develop new technologies
  - Mature through ground-test (bridge TRL gap)
  - Ensure technology can be integrated into systems
    - And with humans and operations (human centered design)
- Exploration Focused
  - NASA is strategizing ultimate goals and architectures
  - Environment needs to be open to trades
- Resource constrained
  - Leverage existing capabilities, and advance them
  - Engage centers and commercial partners
  - *Intentionally* design an environment for collaboration

Three Elements of Test

- One: The Articles Under Test
  - Use ground-based test to mature technology
  - Reduce risk for future missions
  - Types of Articles
    - Flight hardware
    - Path-to-flight hardware
    - Emulators
    - Simulators
    - Data
    - *Humans*
  - Fidelity selection
    - Based on availability
    - Based on research need
    - Based on resources

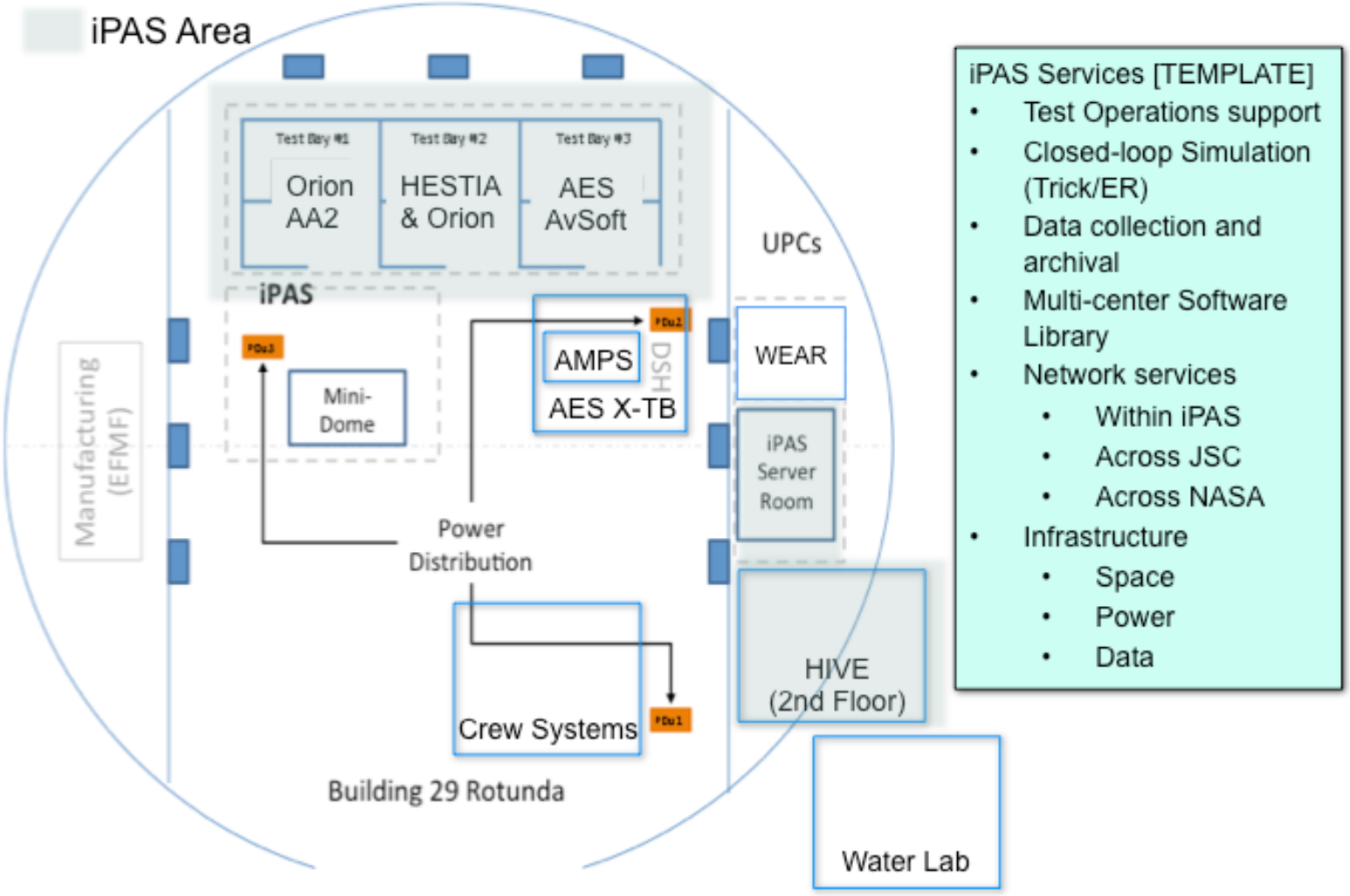


Three Elements of Test

- The Testbed (Infrastructure for Testing)
  - Data networks between systems
  - Environment Chambers
  - Test Execution software
  - Data collection and analysis
  - Library of applications (App Store)
- The Integration Process
  - Manage complexity (Model Based Engineering)
  - Domain tools (MATLAB, Multisim)
  - Integrated Performance Analysis (Trick, GUNNS)
  - Train a team to support integration and test

Train development team through active integration and test

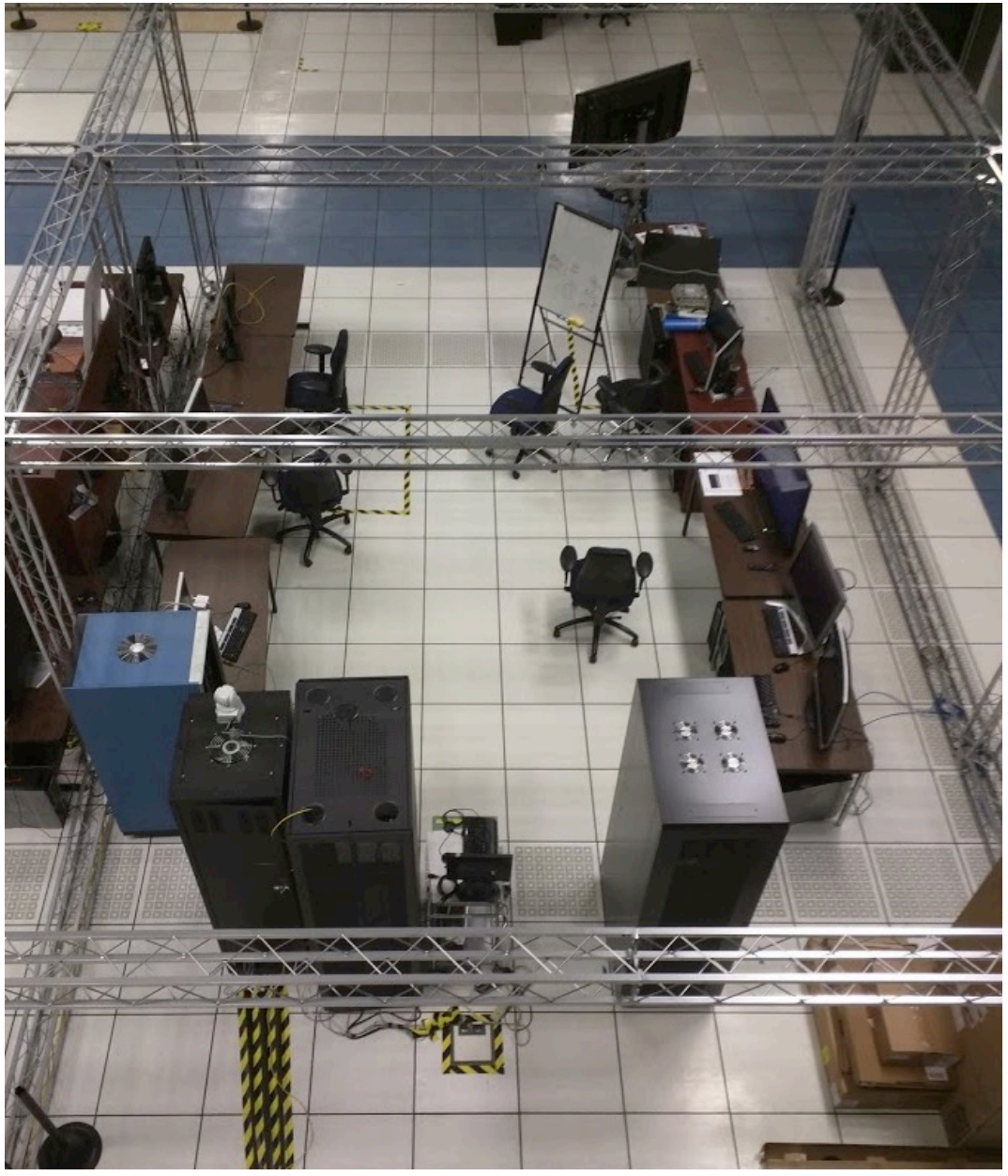
iPAS: Enabling Integration Across Projects



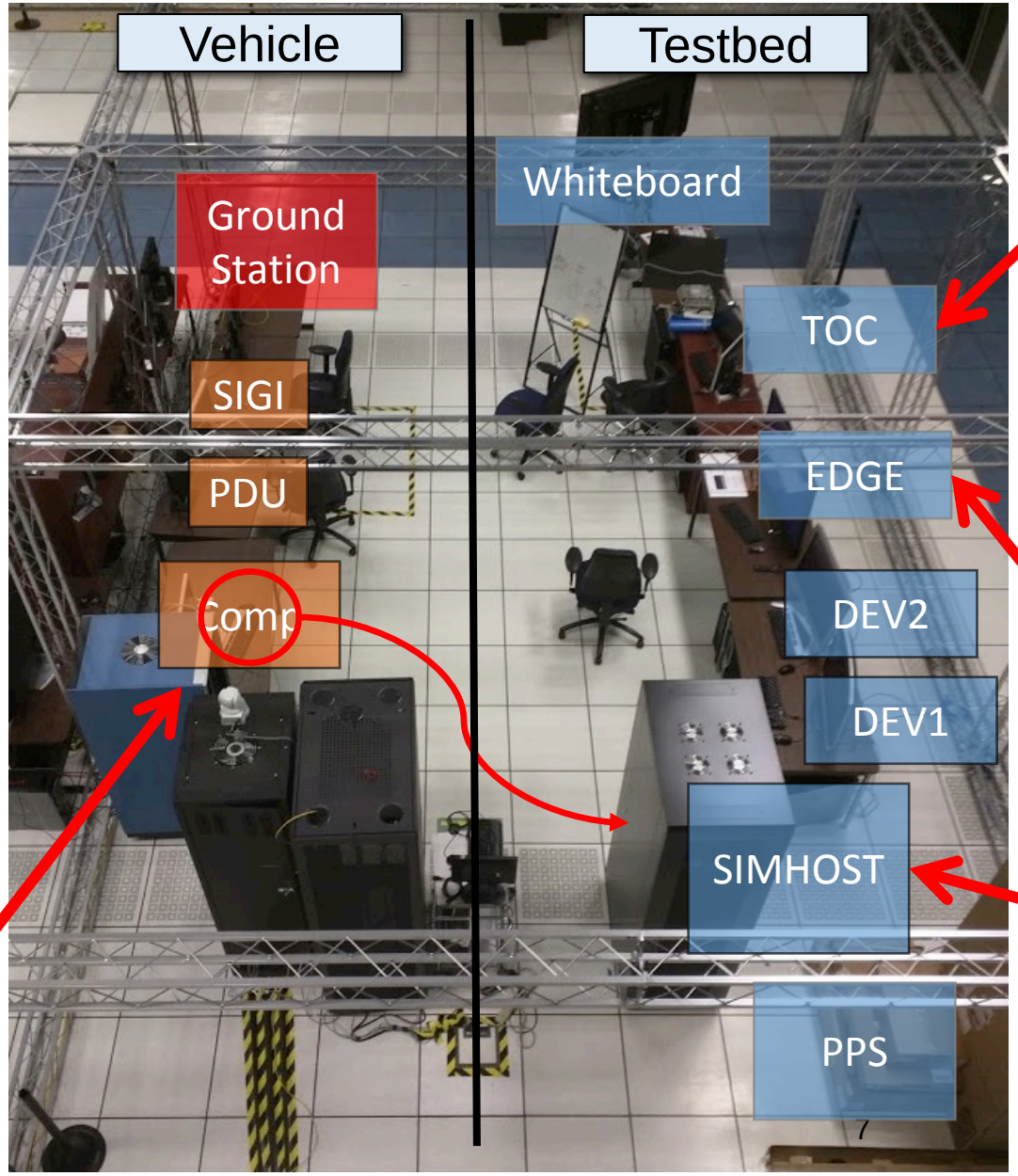
iPAS Services [TEMPLATE]

- Test Operations support
- Closed-loop Simulation (Trick/ER)
- Data collection and archival
- Multi-center Software Library
- Network services
  - Within iPAS
  - Across JSC
  - Across NASA
- Infrastructure
  - Space
  - Power
  - Data

iPAS Testbed Template: Empty



iPAS Testbed Template: Orion AA2



Data Analysis

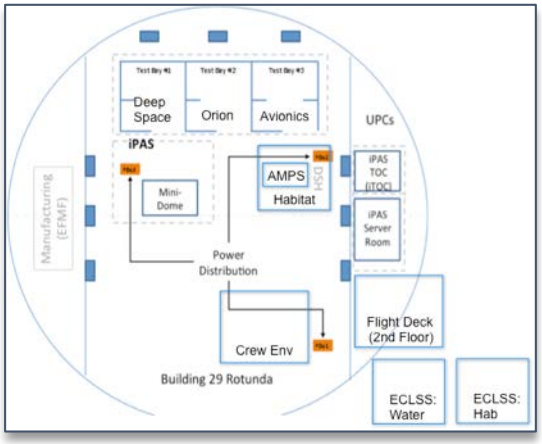
- 1553 Bus Analyzer
- Wireshark
- Oscilloscope
- Time Reference

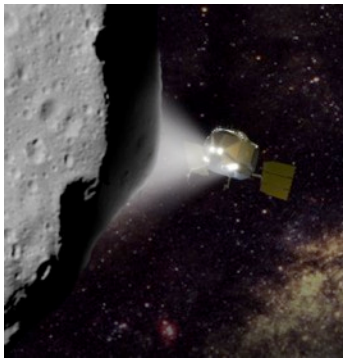
CFS Library

Testbed Services

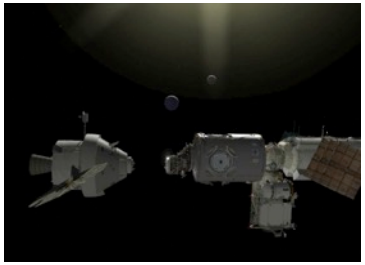
- Test Orchestration
- 3D Graphics
- Simulation & Library

Several Types of Missions

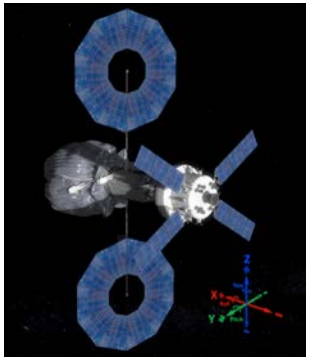




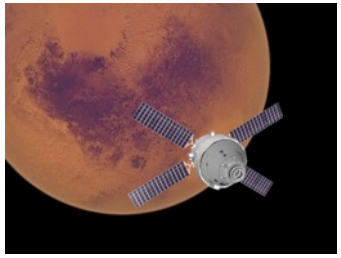
Asteroid Encounter
(2011)



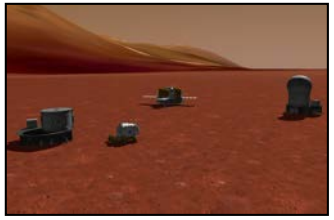
Waypoint
(2012)



Asteroid Redirect
(2013)



Phobos Orbit
(2014)



Mars Surface
(2015)

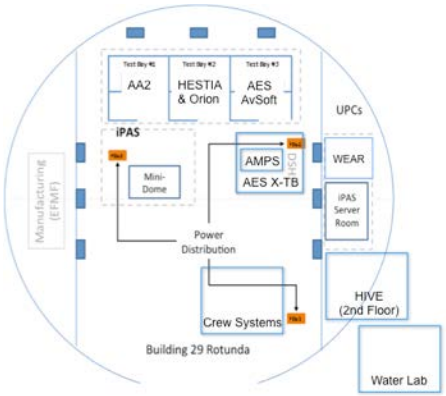
ER products: Sim, Graphics, Domes

Co-location When Feasible

Avionics
- Processors
- Networks
- Wireless
- Comm

GN&C
- ALHAT
- Crew Piloting
- On-board Trajectory Planning

Core Flight SW
- Framework
- Apps Store
- GNC Apps
- Hardware Apps



Delay Tolerant Net
- Mission Evaluation
- DTN on Radio
- DTN on Computer

Advanced Modular Power
- Power Systems
- Integration with avionics in DSH

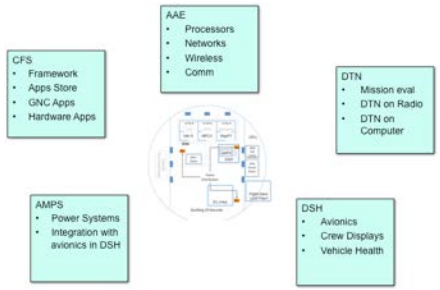
Habitat
- Avionics
- Crew Displays
- Vehicle Health

JSC Lab Integration via Fiber (iPASNet)

B30 – Mission Ops
- MCC emulator
- SNRF interface
- Telemetry and commanding

B16 – GNC/Dome
- Star Tracker
- Star Field
- Cockpits
- Dome

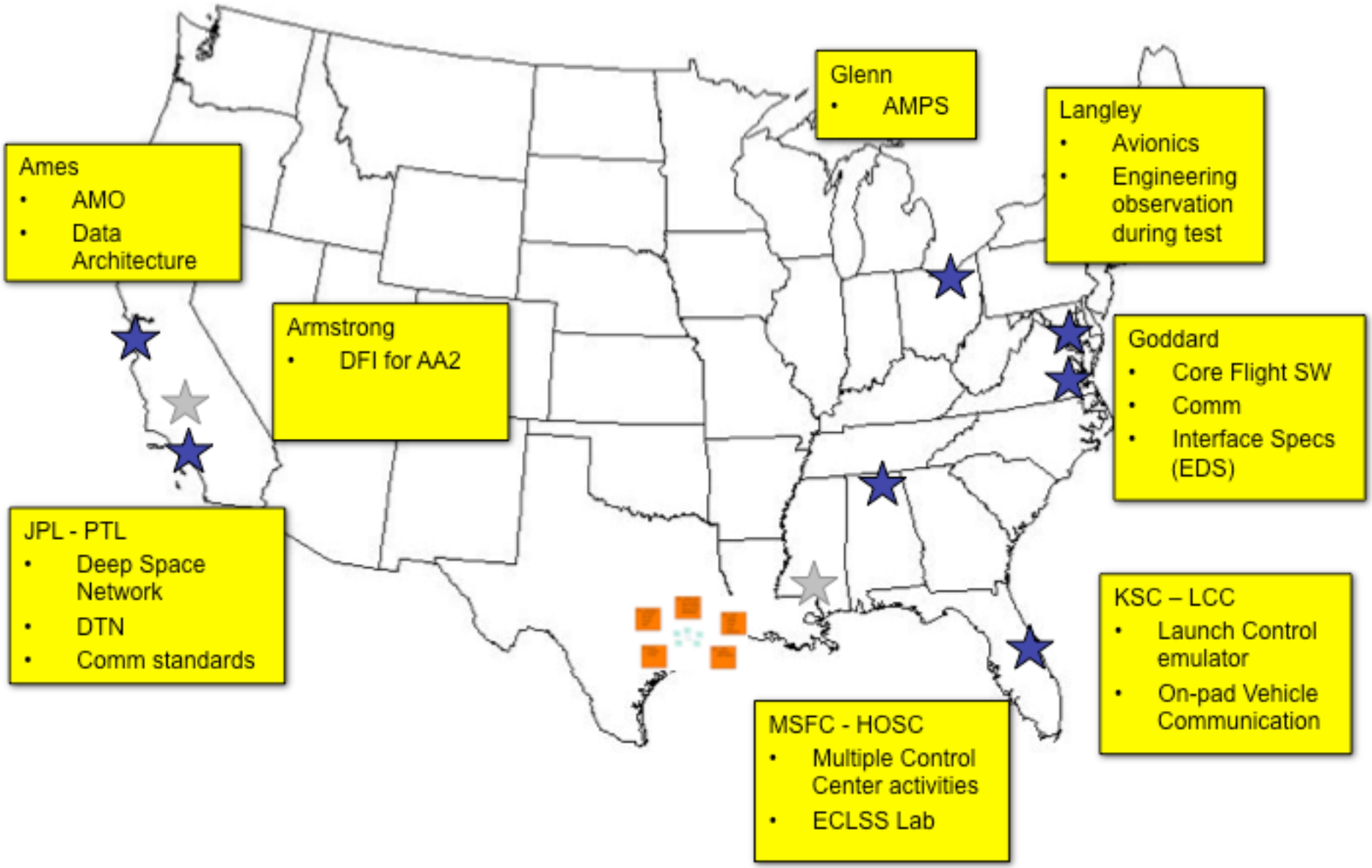
B44 – Comm
- Channel simulator
- TDRSS
- Comm architecture



B7- ECLSS/HESTIA
- Chambers
- PLS lab

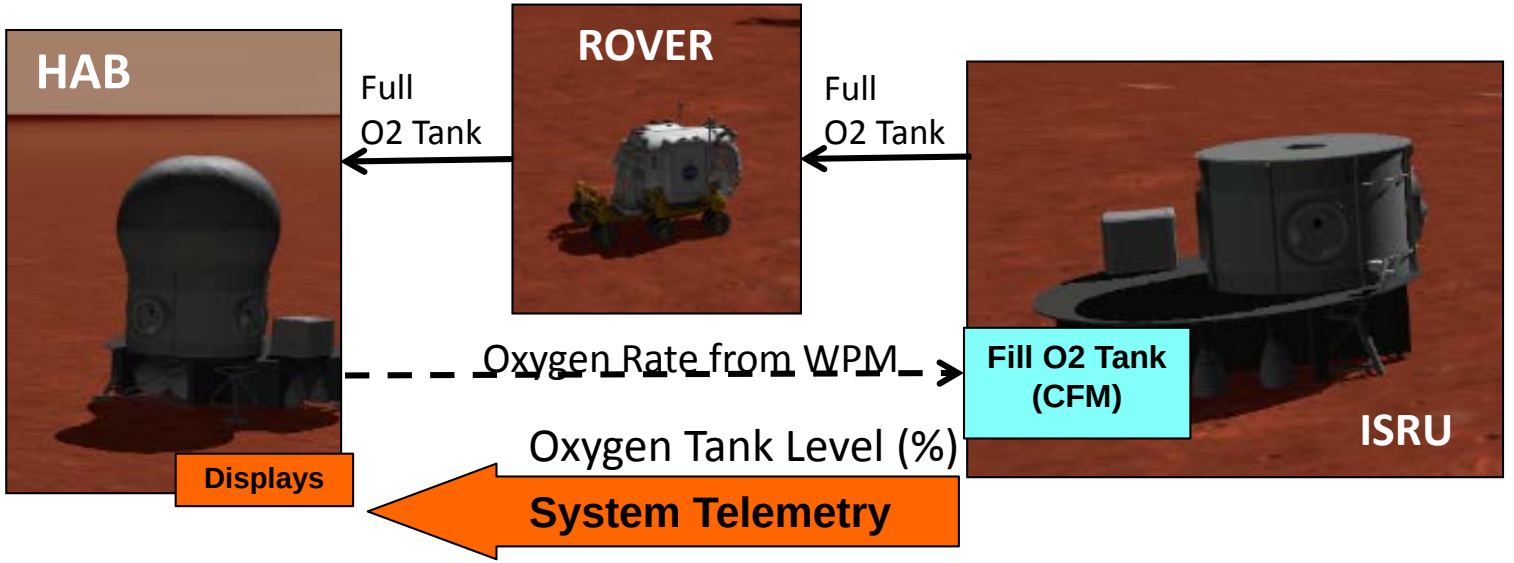
B361 – ISRU/Power
- Interface to power systems

Multi-center Integration



Example: Mars Surface Mission (HESTIA)

- Multi-vehicle surface operations
  - Habitat: Maintain Life Support
  - ISRU: Create Commodities
  - Rover: Commodities Transfer
- Mission Scenario: Oxygen creation, storage, and transfer



HESTIA: Mars Surface Scenario

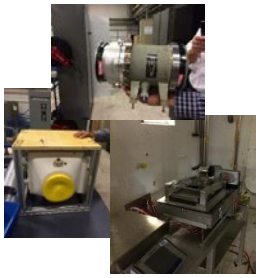
HUMAN EXPLORATION SPACECRAFT TESTBED FOR INTEGRATION AND ADVANCEMENT

FY15 GOAL: Perform initial demonstration of HESTIA Vehicle Integration

Cross-discipline Team

- EC: ECLSS
- EP: ISRU and Power
- ER: Modeling and Simulation
- EG: GN&C
- iPAS: SE&I

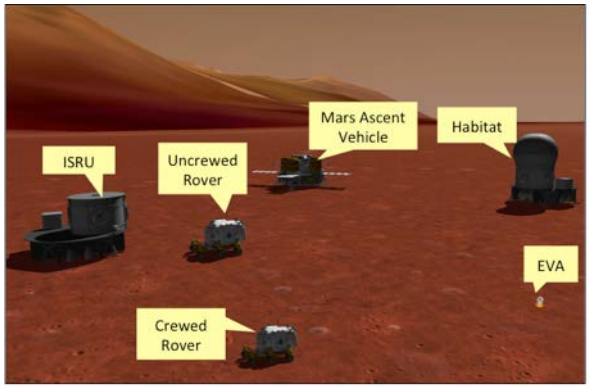
Identify Products
(articles under test)



ECLSS

ISRU

Define Scenario
(support analysis)



Apply SE&I and Test

SharePoint

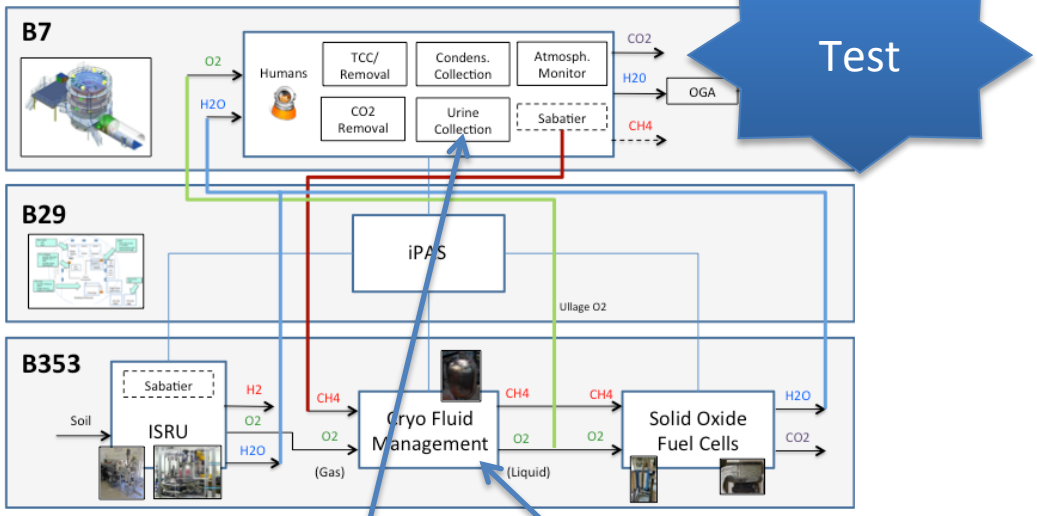
trick

OMG SYSTEMS MODELING LANGUAGE SysML

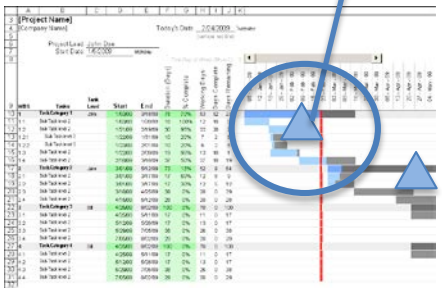
Core Flight System
A paradigm shift in flight software development

Coordination Among Teams

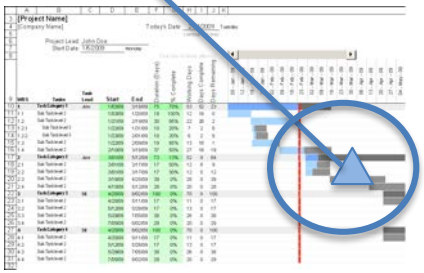
Test Support



- Lay support infrastructure
- Coordinate product delivery
- Prepare for integration *opportunity*
- *Align test with schedule, not the other way around*



ECLSS



ISRU

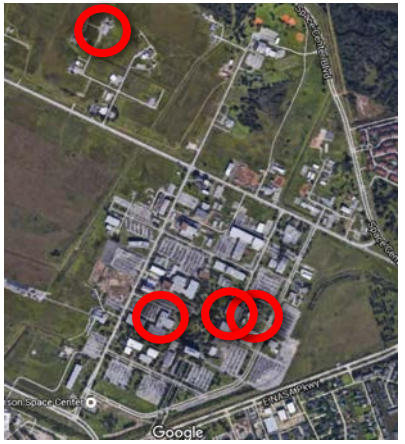
Product/Schedule Alignment

HESTIA Test: September 2015

HUMAN EXPLORATION SPACECRAFT TESTBED FOR INTEGRATION AND ADVANCEMENT

ES Dome (Buildi 16)

• Rover



iPASNet Fiber

Dome (ER)

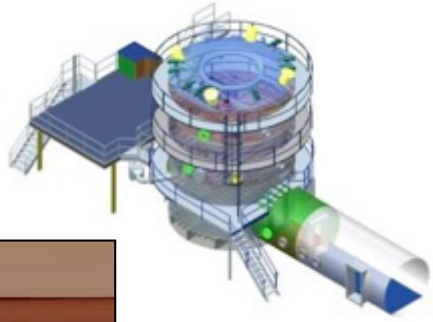
• Habitat/E CLSS

Habitat (Building 7)

iPAS (Building 29)

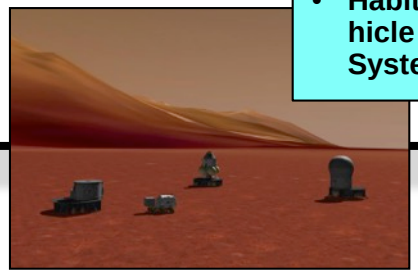
ISRU (Building 3 2)

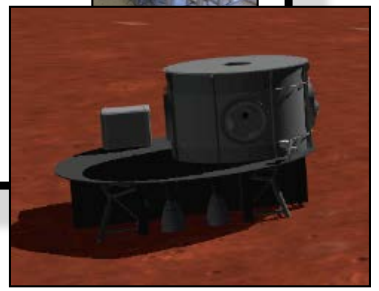
• ISRU



Computer

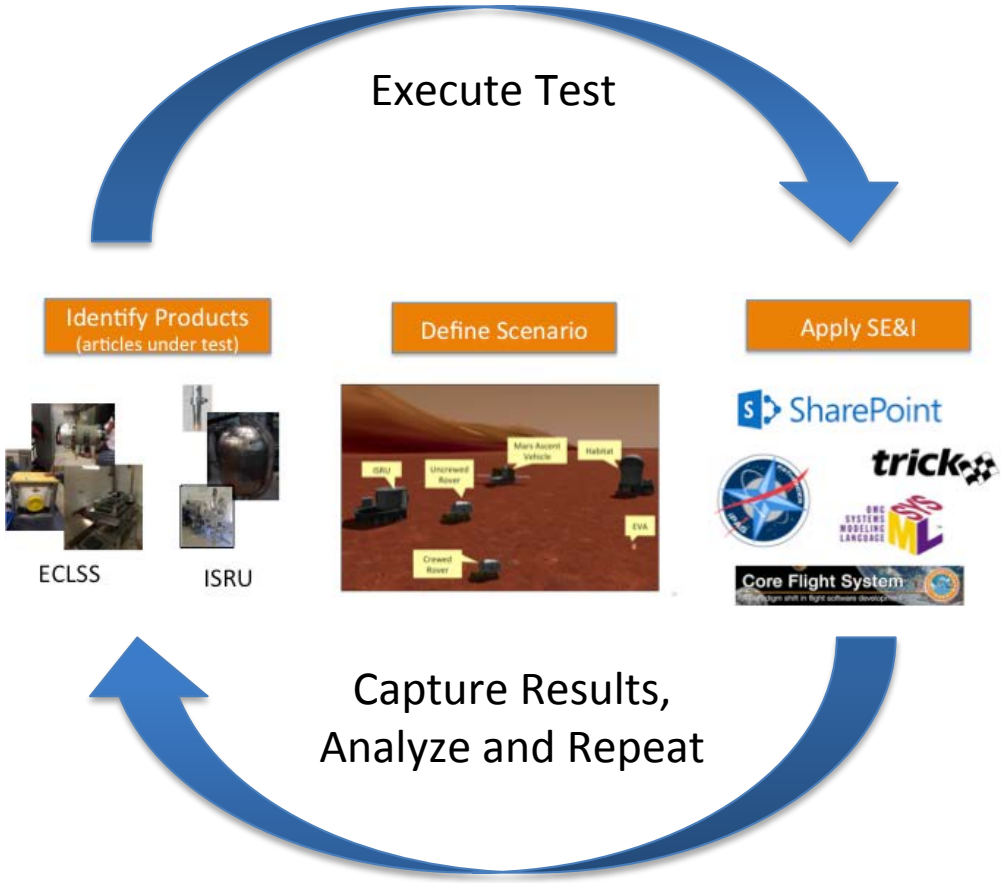
• Habitat/Vehicle Systems





Refinement Through Execution

How do you demonstrate Efficiencies? Through Repeated Application

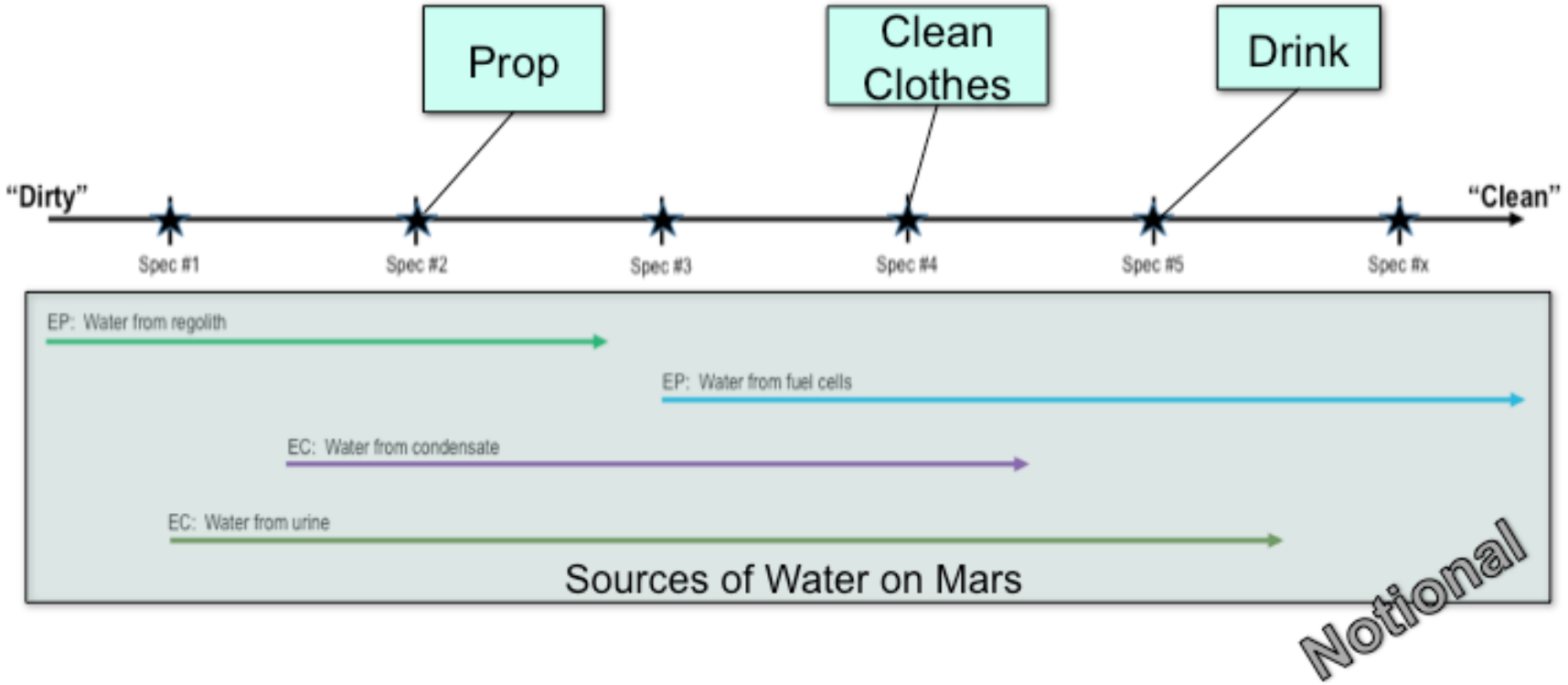


Human Dimension to Test

- Trained Team
  - Opportunity to Learn
- Agile Environment
  - Preserve Success
  - Apply to other projects
- Regular Test Rhythm
  - Within one project
  - Across different projects

Value of Cross-Discipline Integration

- Identify commonalities across disciplines
  - "Clean water": Propulsion vs. ECLSS
  - Discuss water cleaning techniques
  - Common hardware (valves, pumps)



End of Presentation

- Questions